University of Idaho
College of Natural Resources

Carbon Exchange over Wheat Cropping Systems: Comparing Remote Sensing and Direct Flux Measurements

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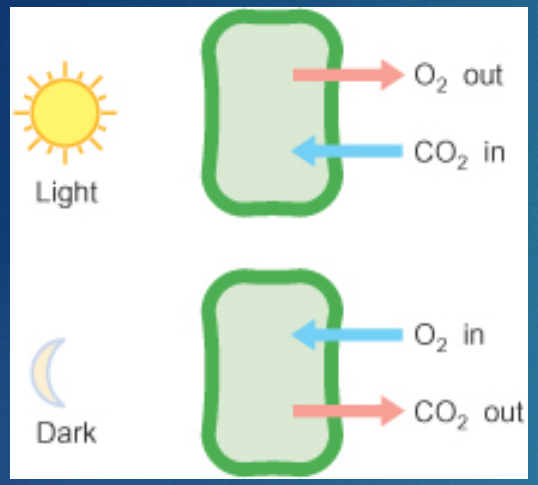
Introduction

Carbon Exchange over Wheat Cropping



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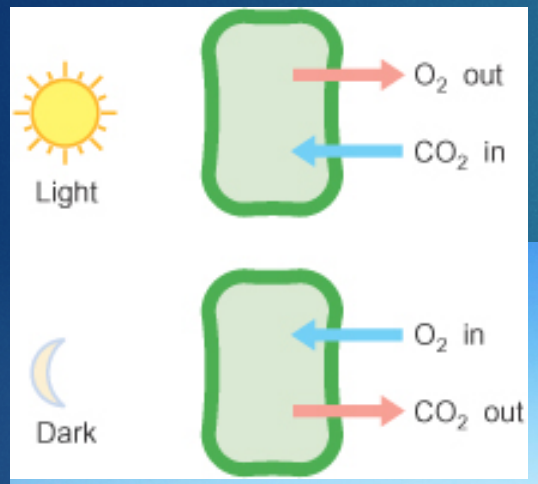

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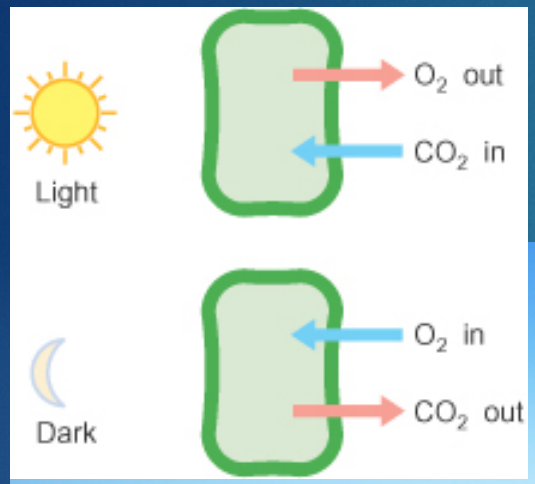

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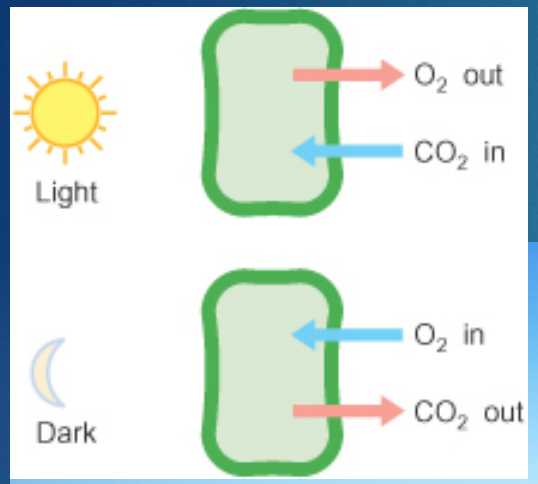

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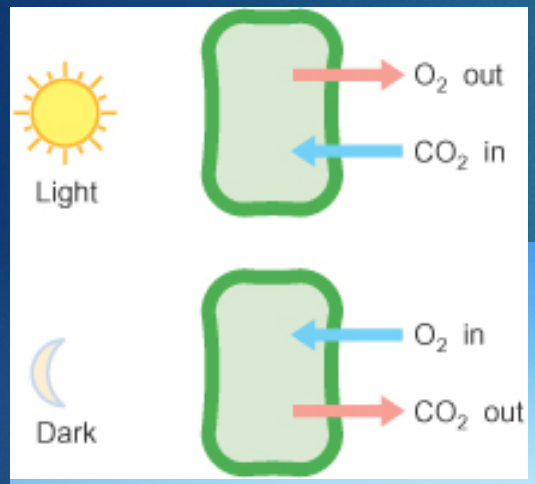

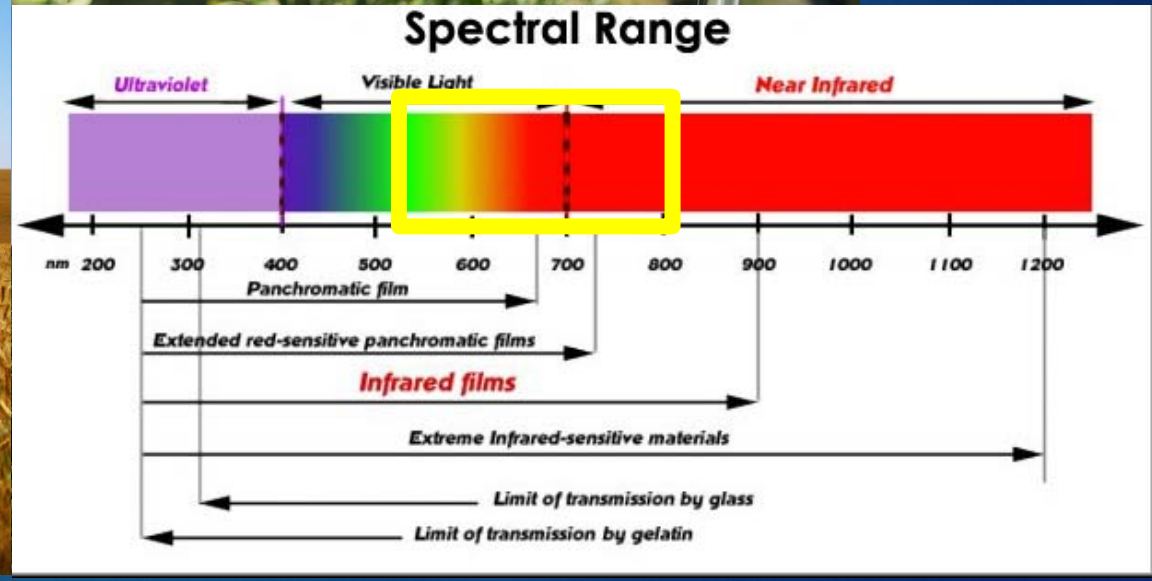

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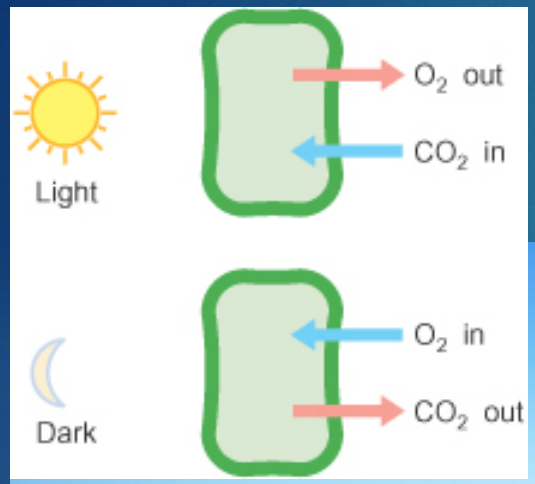


Justification

Research Question:

Is the SRS an accurate means of modeling seasonal growth and daily CO_2 flux?

Hypothesis

- We believe the NDVI data will correlate well with seasonal growth models
- We also believe the PRI data will correlate well with diurnal flux models

Why Does This Matter??

$$ + Accessibility

$$ + Accessibility

SRS

- Cost: $200-300
- Easy to set up

Flux Tower

- Cost: $50,000 (complete set)
- Arduous set-up/configuration process

Implications

- Agricultural:
  - Farmers of soft-white winter wheat could use SRS to accurately model their ripening rate, then make changes to optimize yield
- Research:
  - May lead to an improved understanding of how croplands exchange, store carbon in response to climate change
  - Could be used as a ground-base/gap-filler for satellite measurements

Methods

The Tools

The Tools

Spectral Reflectance Sensor (SRS)

The Tools

Spectral Reflectance Sensor (SRS)

Eddy Covariance Flux Tower

The Tools

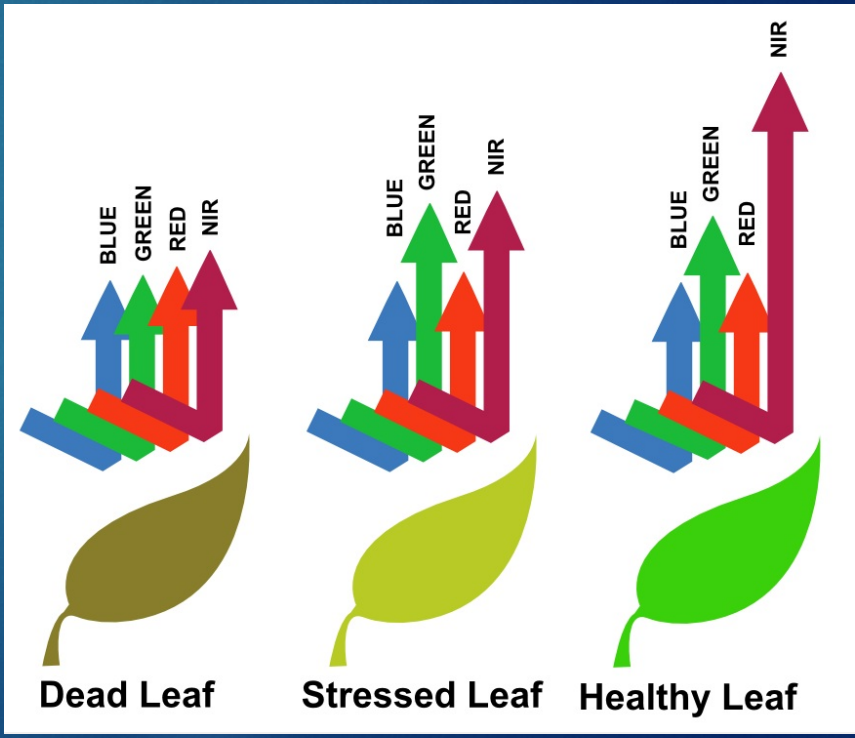
Spectral Reflectance Sensor (SRS)

Eddy Covariance Flux Tower

SPAD-502
Meter

Spectral Reflectance Sensor

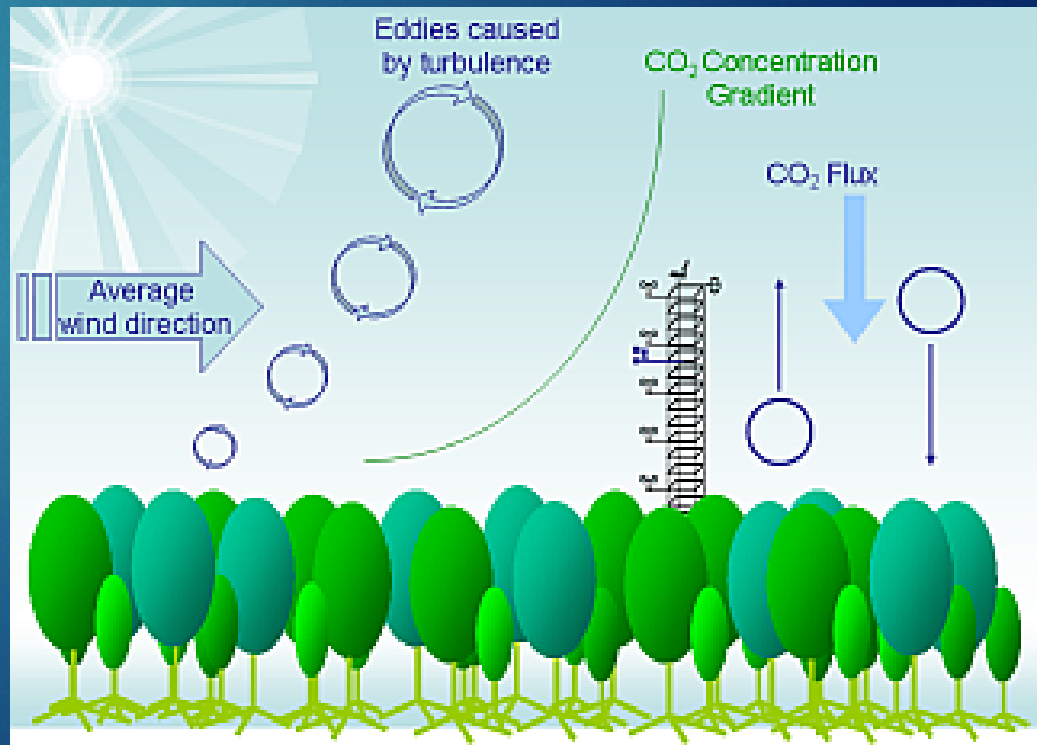
- Pioneered by Steve Garrity, former grad student at the U of I
- Measures the Normalized Difference Vegetation Index (NDVI) and the Photochemical Reflectance Index (PRI)
- NDVI can be used to model seasonal growth
- PRI can be used to model diurnal flux
- Takes measurements every 5 minutes



Eddy Covariance Flux Tower

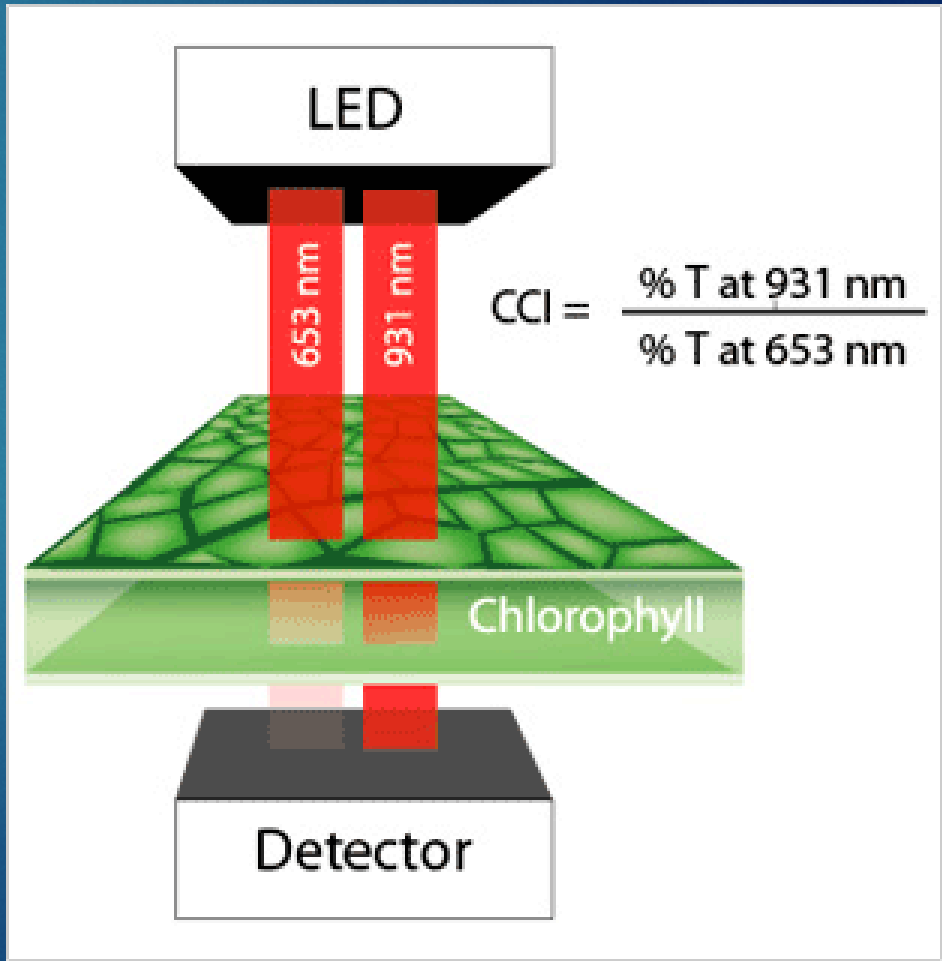
- Measures a multitude of different variables: our focus in on net CO_2 flux
- Models both diurnal flux and seasonal growth
- Measurements taken at a frequency of 10 Hz

  (10 measurements per second)



SPAD-502 Meter

- Measures chlorophyll content in nmol/cm^2
- Hand-held device
- Used as ground-validation tool



Setup

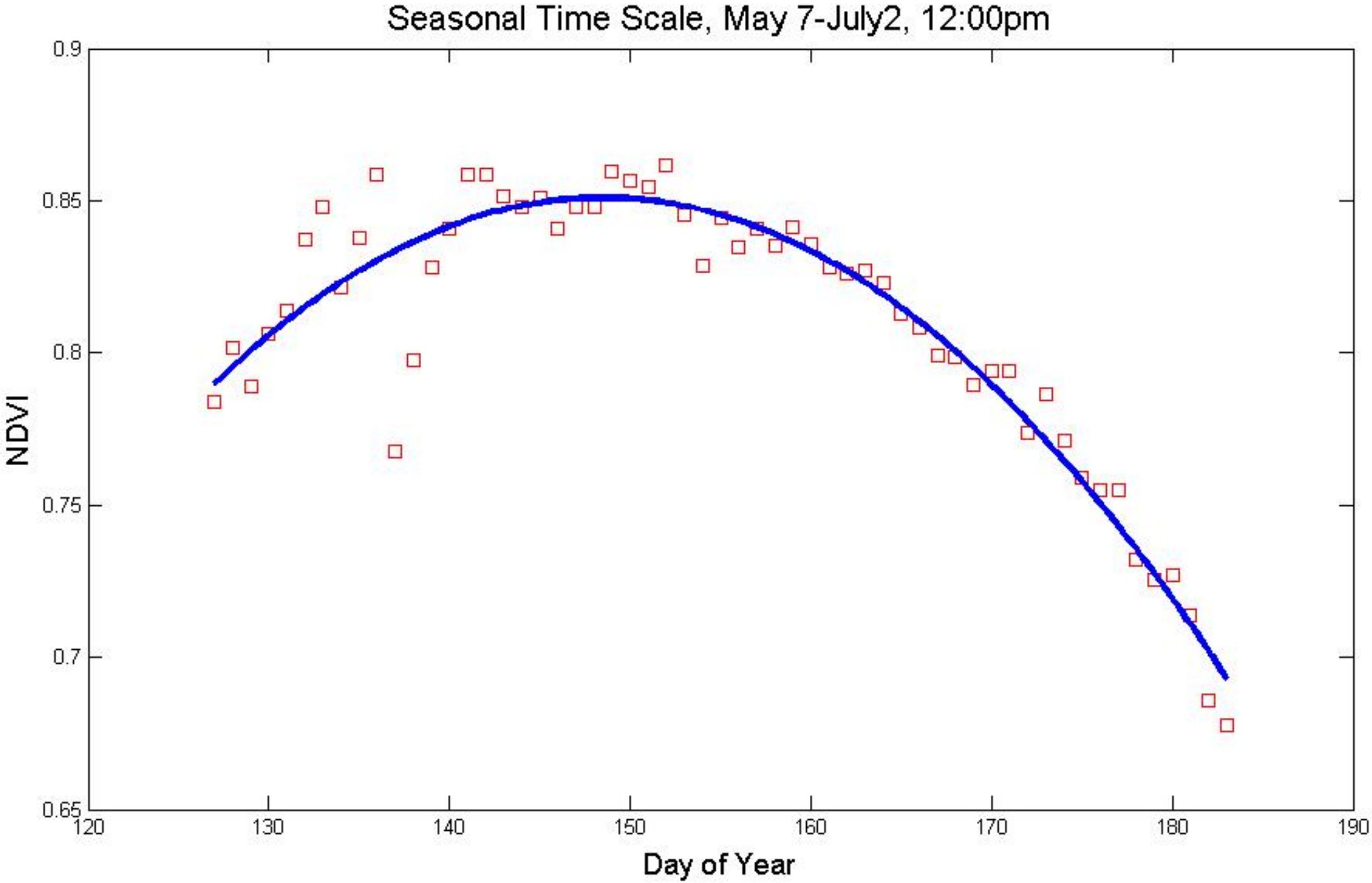
Setup

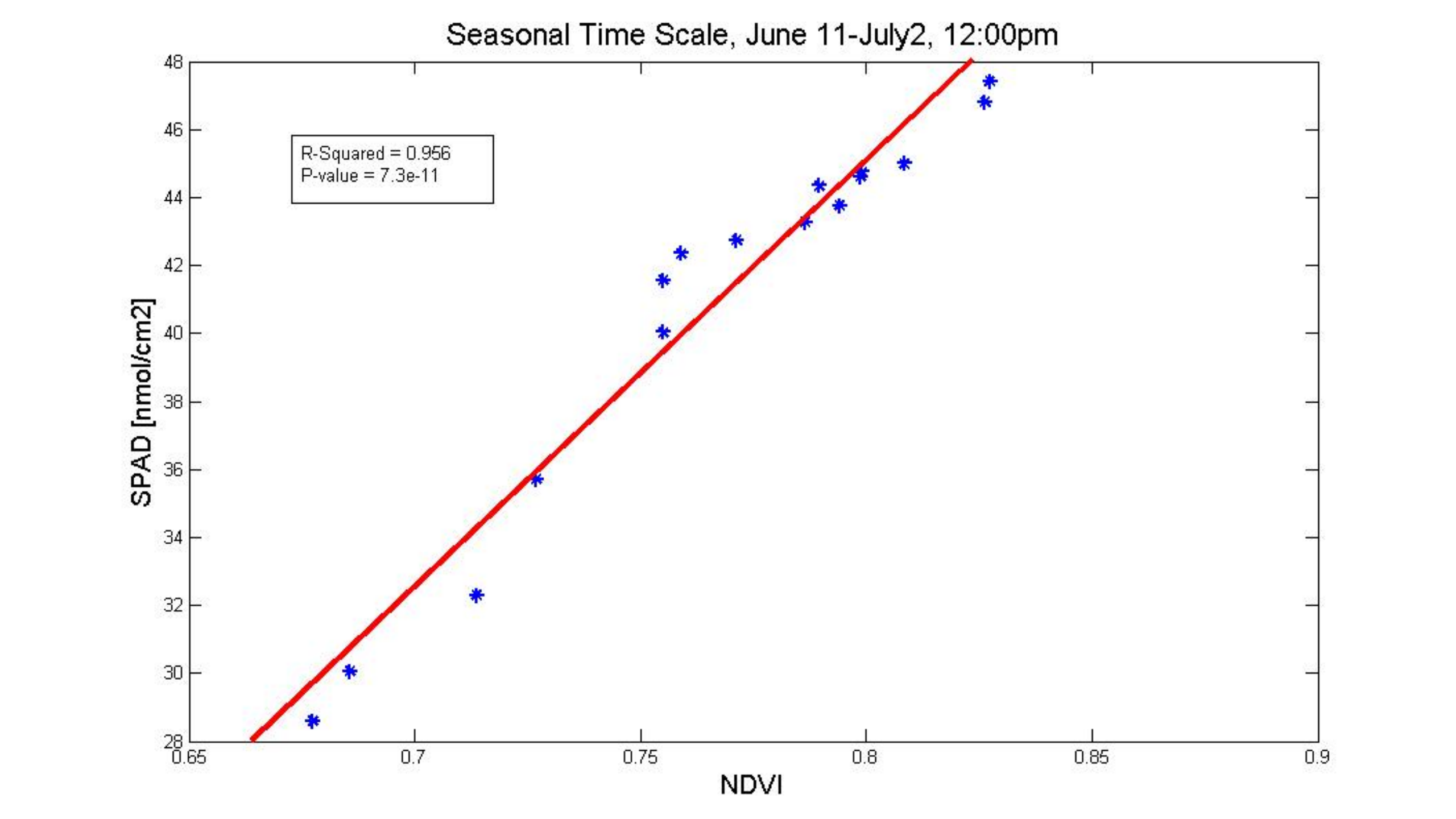
Setup

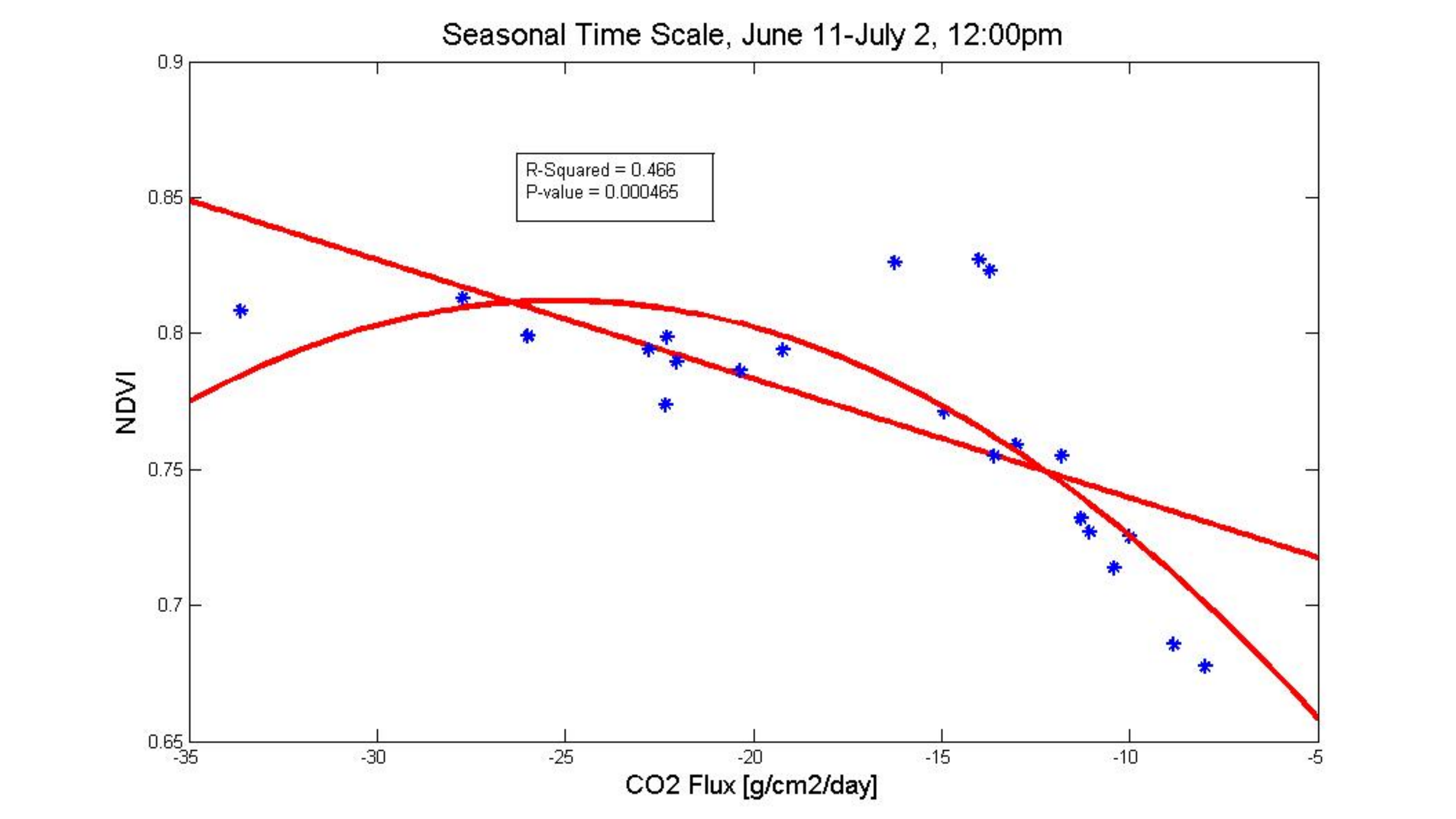
Comparisons

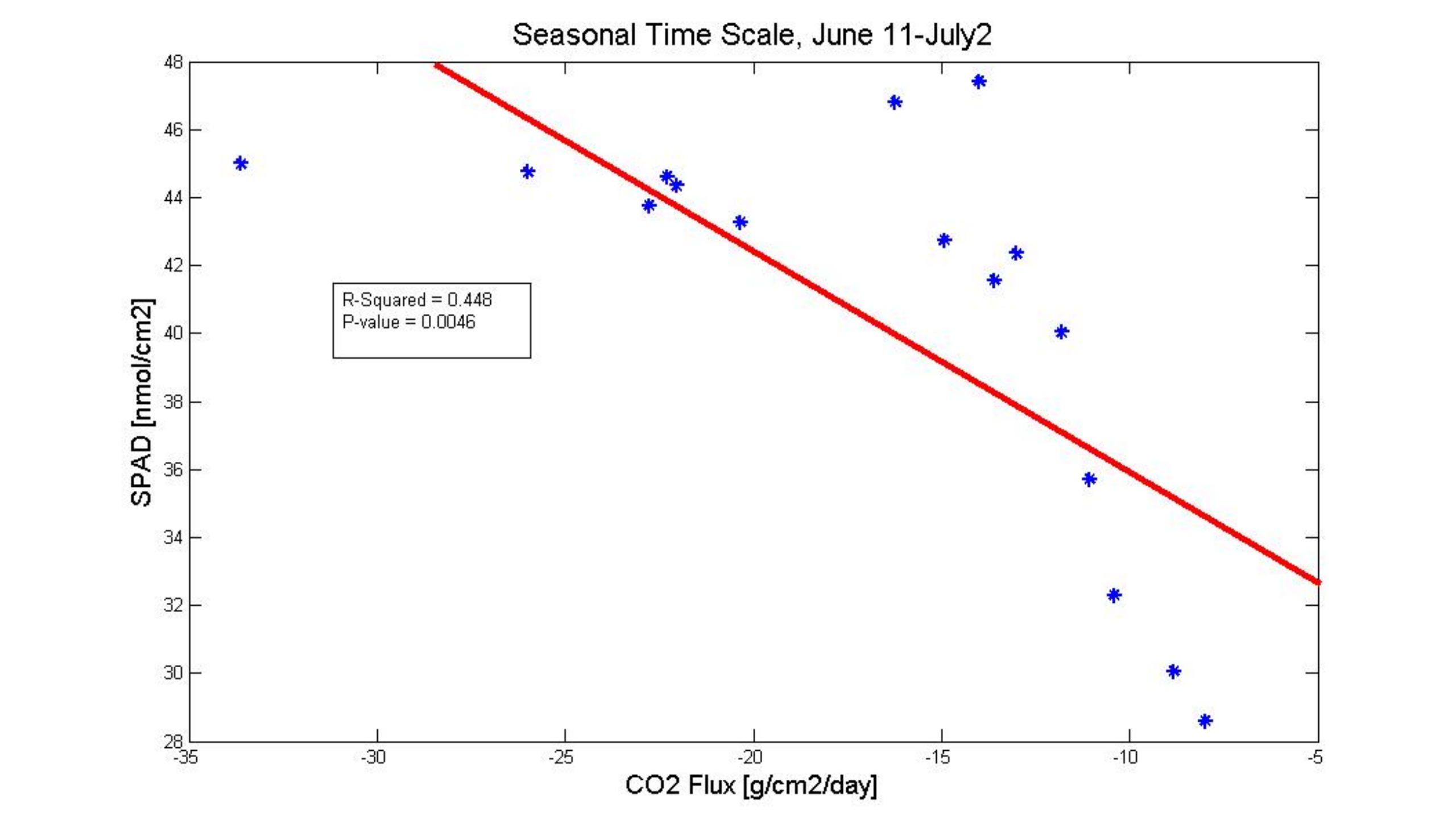
1. Regression of Seasonal Phenomena
   - NDVI vs SPAD
   - NDVI vs CO_2 Flux (seasonal)
   - Flux vs SPAD
2. Regression of Diurnal Phenomena
   - PRI vs CO_2 Flux (daily)

Results


Seasonal Time Scale, May 7-July2, 12:00pm
NDVI
Day of Year
0.9
0.85
0.8
0.75
0.7
0.65
120
130
140
150
160
170
180
190


Seasonal Time Scale, June 11-July2, 12:00pm
R-Squared = 0.956
P-value = 7.3e-11
SPAD [nmol/cm2]
NDVI
48
46
44
42
40
38
36
34
32
30
28
0.65
0.7
0.75
0.8
0.85
0.9


Seasonal Time Scale, June 11-July 2, 12:00pm
R-Squared = 0.466
P-value = 0.000465
NDVI
CO2 Flux [g/cm2/day]
0.9
0.85
0.8
0.75
0.7
0.65
-35
-30
-25
-20
-15
-10
-5


Seasonal Time Scale, June 11-July2
R-Squared = 0.448
P-value = 0.0046
SPAD [nmol/cm2]
CO2 Flux [g/cm2/day]
48
46
44
42
40
38
36
34
32
30
28
-35
-30
-25
-20
-15
-10
-5

Seasonal Time Scale, June 11-July2

SPAD [nmol/cm2]

CO2 Flux [g/cm2/day]

High Photosynthetic Potential

Low Photosynthetic Potential

Seasonal Time Scale, June 11-July2

High Photosynthetic Performance

Low Photosynthetic Performance

High Photosynthetic Potential

Low Photosynthetic Potential

SPAD [nmol/cm2]

CO2 Flux [g/cm2/day]

48
46
44
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30
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-35
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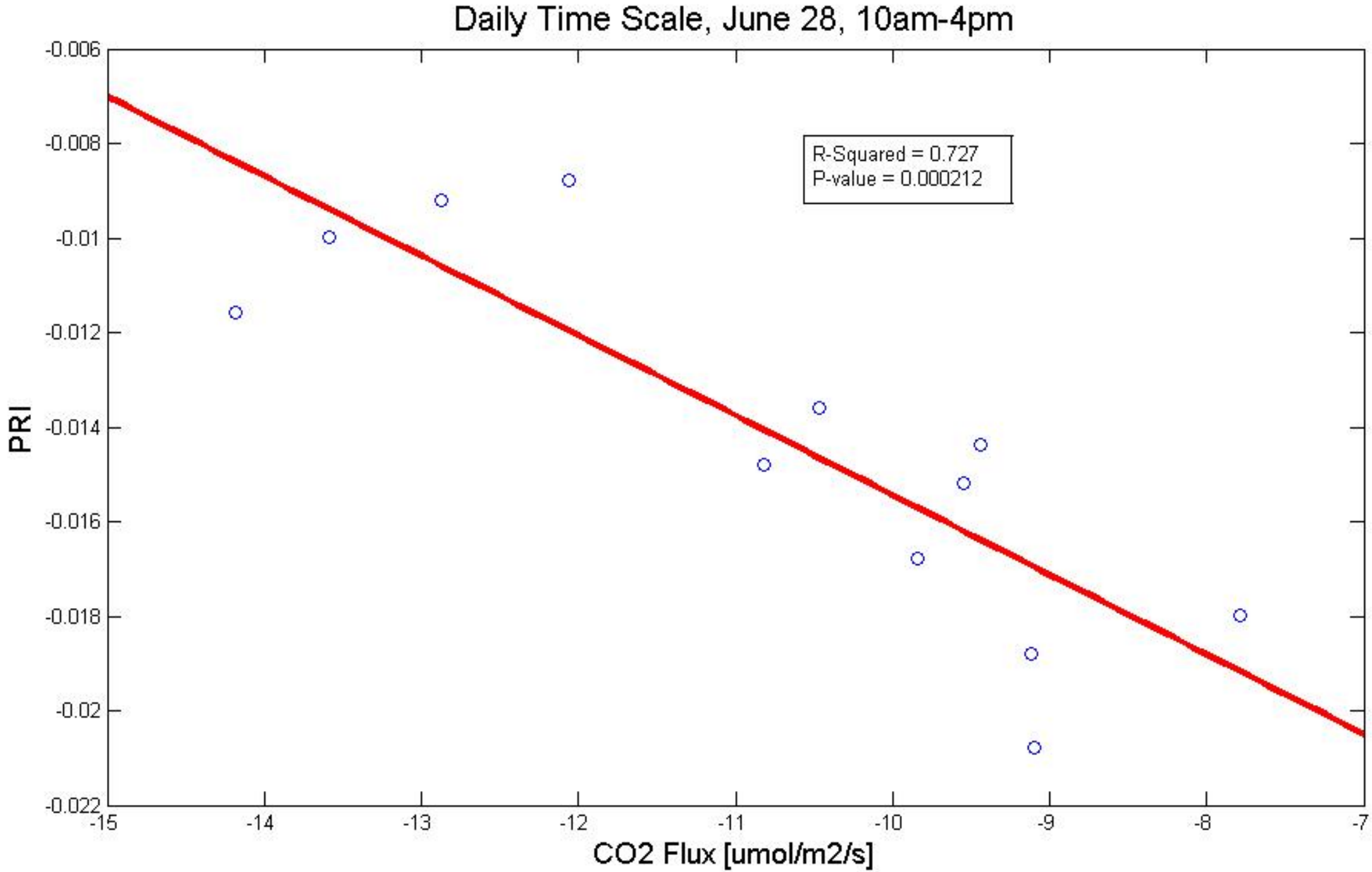
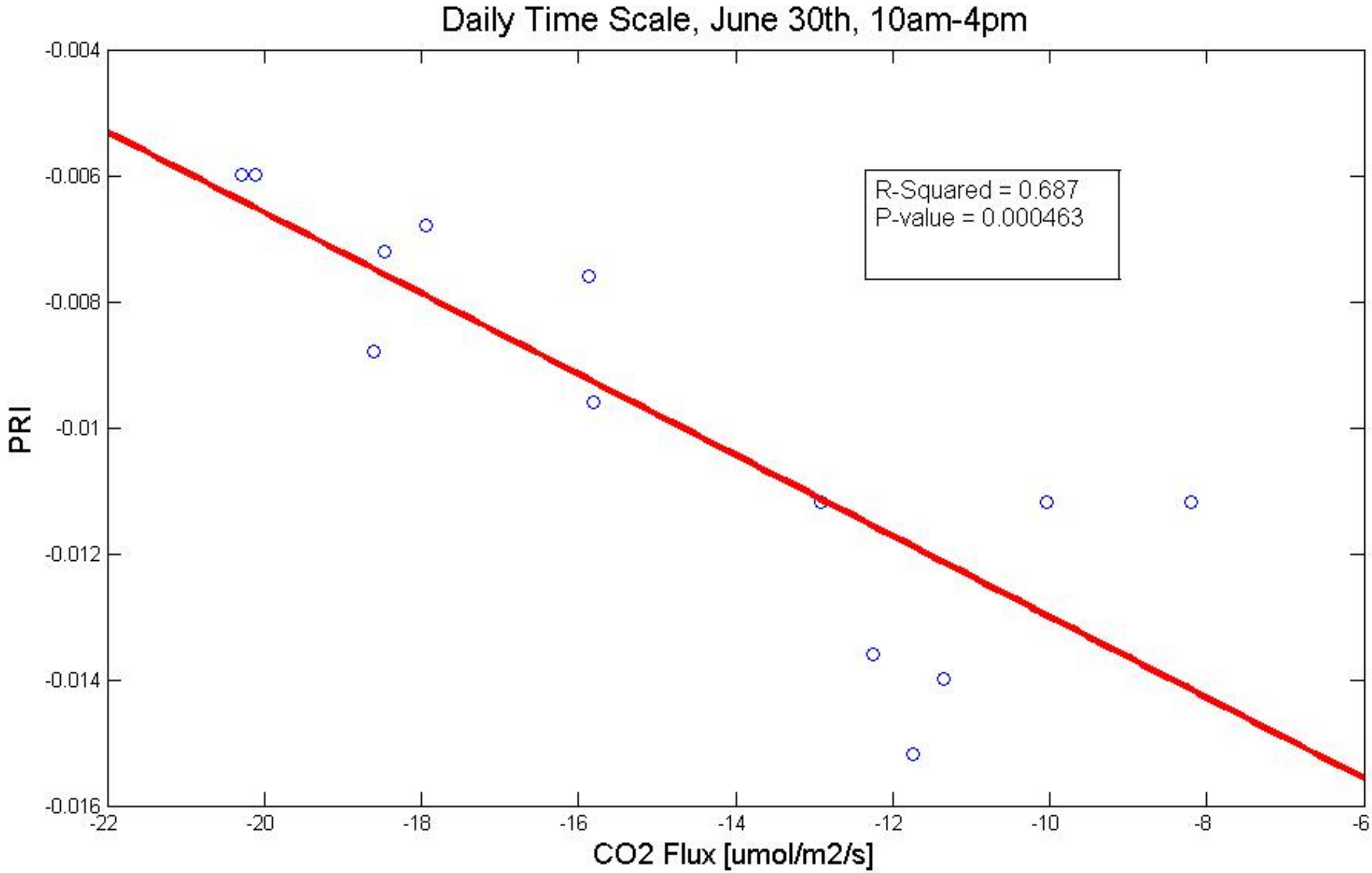

Daily Time Scale, June 28, 10am-4pm
R-Squared = 0.727
P-value = 0.000212
PRI
CO2 Flux [umol/m2/s]
-0.006
-0.008
-0.01
-0.012
-0.014
-0.016
-0.018
-0.02
-0.022
-15
-14
-13
-12
-11
-10
-9
-8
-7


Daily Time Scale, June 30th, 10am-4pm
R-Squared = 0.687
P-value = 0.000463
PRI
CO2 Flux [umol/m2/s]
-0.004
-0.006
-0.008
-0.01
-0.012
-0.014
-0.016
-22
-20
-18
-16
-14
-12
-10
-8
-6

Conclusion

Take-Aways

1. SRS works, and it works well!!!
2. NDVI nicely models physical changes, highly correlated with seasonal CO_2 flux
3. PRI models chemical and biological changes, highly correlated with diurnal CO_2 flux
4. SRS can't replace Flux Tower, but SRS can compliment it
5. Despite good correlations there were some inconsistencies
6. Hypothesis is supported, but not absolute

Implications

- Agricultural:
  - Farmers of soft-white winter wheat could use SRS to accurately model their ripening rate, then make changes to optimize yield
- Research:
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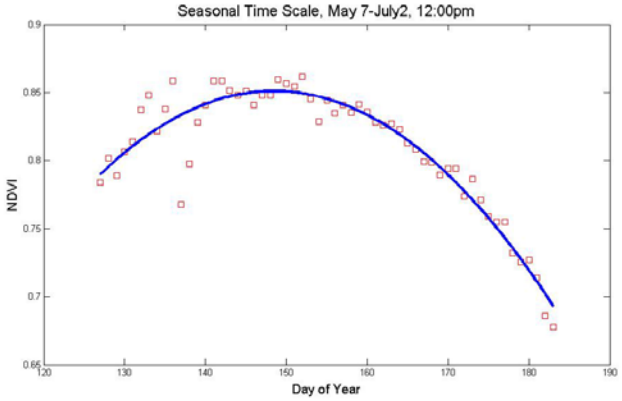
Thank You!

QUESTIONS?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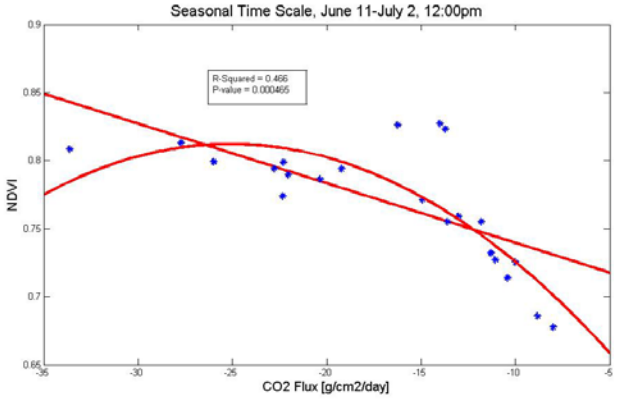
NDVI
Day of Year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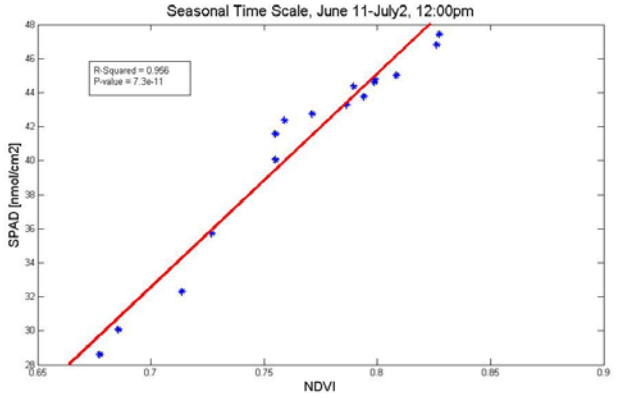
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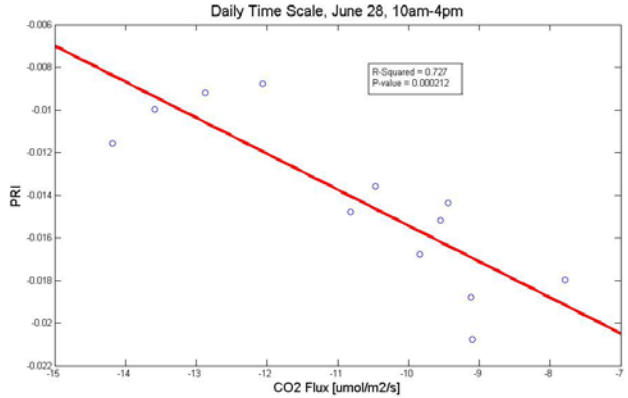
NDVI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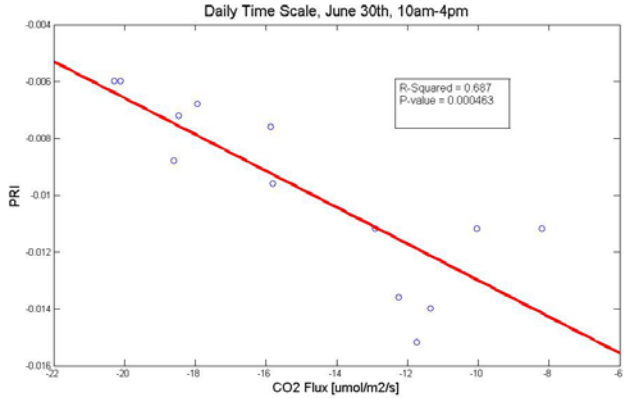
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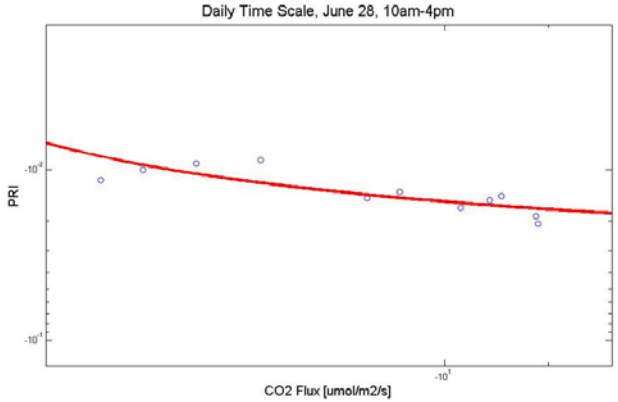
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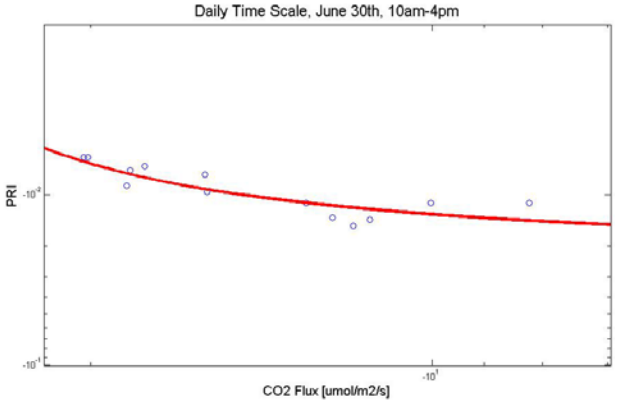
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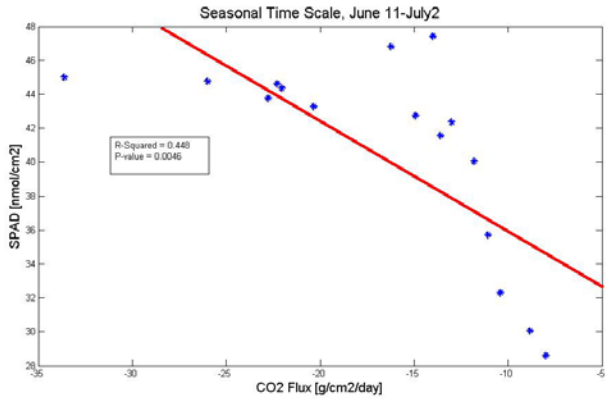
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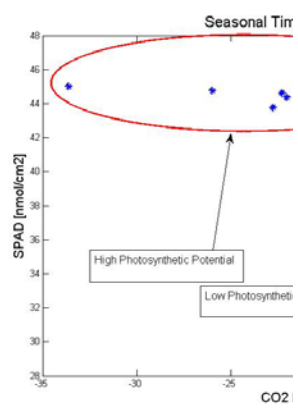
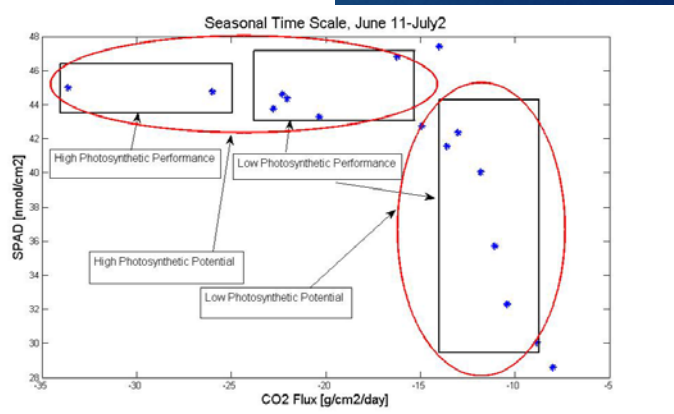

Seasonal Tim
SPAD [nmol/cm2]
High Photosynthetic Potential
Low Photosyntheti
CO2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High Photosynthetic Performance
Low Photosynthetic Performance
High Photosynthetic Potential
Low Photosynthetic Potential
SPAD [nmol/cm2]
CO2 Flux [g/cm2/day]